International Comparisons of Government R&D Tax Policies

In most OECD countries, government not only provides direct financial support for R&D activities but also uses indirect mechanisms such as tax relief to promote national investment in science and technology. Indeed, tax treatment of R&D in OECD countries is broadly similar, with some variations in the use of R&D tax credits (OECD 1996, 1999a). The following are the main features of the R&D tax instruments:

- Almost all countries (including the United States) allow industry R&D expenditures to be 100 percent deducted from taxable income in the year they are incurred.
- In most countries, R&D expenditures can by carried forward or deducted for 3 to 10 years. (In the United States, there is a 3-year carry-forward on R&D expenditures and a 15-year carry-forward on R&D capital assets.)
- About half the countries (including the United States; see "U.S. Federal and State R&D Tax Credits") provide some type of additional R&D tax credit or incentive, with a trend toward using incremental credits. A few countries also use more targeted approaches, such as those favoring basic research.
- Several countries have special provisions that favor R&D in small and medium-size enterprises. (In the United States, credit provisions do little to help small start-up firms, but more direct Federal R&D support is provided through grants to small firms. See "Federal Support for Small Business R&D.")
- A growing number of R&D tax incentives are being offered at the subnational (provincial and state) levels, including in the United States (see "U.S. Federal and State R&D Tax Credits").[52]

International Public- and Private-Sector R&D and Technology Cooperation

Particularly in light of recent advances in information and communication technologies, international boundaries have become considerably less important in structuring the conduct of R&D and the use of research collaborations. Indicators of R&D globalization illustrate these R&D landscape changes for each of the R&D-performing sectors. Growth in international academic research collaboration is exhibited by the substantial increase in international co-authorship trends. (See chapter 6.) Extensive global growth in public-sector and industrial R&D activities is detailed below.

Public-Sector Collaboration

The rapid rise in international cooperation has spawned activities that now account more than 10 percent of government R&D expenditures in some countries. A significant share of these international efforts results from collaboration in scientific research involving extremely large "megascience" projects. Such developments reflect scientific and budgetary realities: Excellent science is not the domain of any single country, and many scientific problems involve major instrumentation and facility costs that appear much more affordable when cost-sharing arrangements are in place. Additionally, some scientific problems are so complex and geographically expansive that they simply require an international effort.[53] As a result of these concerns and issues, an increasing number of S&T-related international agreements have been forged between the U.S. government and its foreign counterparts during the past decade.

U.S. Government's Use of International S&T Agreements

International governmental collaboration in S&T and R&D activities appears to be a growing phenomenon. There are few sources of systematic information on government-to-government cooperative activities, however. A report by the U.S. General Accounting Office (GAO 1999) provides a snapshot of seven Federal agencies' international S&T agreements that were active during FY 1997. The GAO accounting is only for official, formal agreements and therefore provides a lower-bound estimate of the number of governmental global S&T collaborations. Most international cooperation is continuous and ongoing and takes place outside the framework of official, formal agreements. Nonetheless, the GAO study found that these seven agencies—DOE, NASA, NIH, NIST, the National Oceanographic and Atmospheric Administration (NOAA), NSF, and the Department of State—participated in 575 such agreements with 57 countries, 8 international organizations, and 10 groups of organizations or countries. Fifty-four of these agreements were broad-based bilateral arrangements between the U.S. government and governments of foreign countries—commonly referred to as "umbrella" or "framework" agreements. The remaining 521 agreements were bilateral agreements between research agencies and their counterparts in foreign governments and international organizations (381) or multilateral agreements (140) to conduct international cooperative research, provide technical support, or share data or equipment.

Generally, such agreements—which are indicative of government interest to cooperate internationally in R&D—have no associated budget authority. Nor is there a system in place to link international S&T agreements with actual spending on cooperative R&D. According to a study by the Rand Corporation, the U.S. government spent $3.3 billion on R&D projects involving international cooperation in FY 1995 (which may or may not have been associated with international S&T agreements) and an additional $1.5 billion on non-R&D activities associated with international S&T agreements (Wagner 1997).

[52] See also Poterba (1997) for a discussion of international elements of corporate R&D tax policies.

[53] See OECD (1993 and 1998c) Megascience Forum publications for a concise summary of the history, concepts, and issues behind mega-projects and megascience activities. Additionally, Georghiou (1998) provides a thorough discussion on current global facilities in big science and the emergence of global cooperative programs among governments.

Among the seven agencies that GAO reviewed, DOE participated in the largest number of official international S&T agreements (257, or 45 percent of the 575 total). (See text table 2-17.) This total included almost 100 multilateral agreements with the International Energy Agency (IEA), which represents the United States and 23 other countries with common scientific interests and priorities. NASA was second among the seven agencies in terms of participation in total international S&T agreements (127, including 15 multilateral agreements with the European Space Agency).

In addition to the 140 multilateral agreements, these seven agencies participated in bilateral S&T agreements with countries from almost every region of the world. In terms of the sheer numbers, U.S. agencies were most active in their participation with Japan (78): DOE and NASA reported the largest number of their bilateral S&T agreements with that country. After Japan, U.S. S&T agreements were most commonly reported with Russia (38), China (30), and Canada (25). DOE reported more agreements with Russia and China than did any other agency; NASA accounted for the largest number of agreements with Canada. The prevalence of DOE and NASA in these and other international S&T agreements reflects the megascience attributes associated with their missions. Of the other five agencies in the GAO report, only NIST reported more than five bilateral agreements with any single country (Japan and South Korea) in FY 1997. NIST also listed five agreements with Russia and three with Canada.

Text table 2–17.
Total and bilateral international S&T agreements, by selected agency and country: FY 1997

	Total	Energy	NASA	NIH	NIST	NOAA	NSF	State
Total	575	257	127	44	56	32	26	33
Multilateral	140	107	15	1	7	7	3	0
Bilateral[a]	435	150	112	43	49	25	23	33
Asia	151	56	31	13	24	10	10	7
Japan	78	28	26	4	13	2	4	1
China	30	20	0	3	1	2	3	1
Korea	20	7	0	2	7	1	2	1
Other	23	1	5	4	3	5	1	4
Europe	150	48	37	16	11	7	13	18
Russia	38	16	8	4	5	1	3	1
France	21	9	6	1	0	4	1	0
Germany	15	1	8	3	0	0	3	0
United Kingdom.	11	5	3	1	0	1	1	0
Italy.	11	2	4	3	1	0	0	1
Other.	54	15	8	4	5	1	5	16
South & Central America	48	22	13	2	6	1	0	4
Venezuela	15	12	0	1	1	0	0	1
Brazil	12	3	6	0	1	1	0	1
Argentina	10	3	4	0	2	0	0	1
Chile	8	2	3	1	1	0	0	1
Other	3	2	0	0	1	0	0	0
North America	34	8	14	4	4	3	0	1
Canada	25	5	14	1	3	2	0	0
Mexico	9	3	0	3	1	1	0	1
South Pacific	24	8	11	2	1	1	0	1
Australia	16	5	9	1	0	1	0	0
Other	8	3	2	1	1	0	0	1
Africa	15	6	2	2	2	1	0	2
South Africa	9	3	2	1	1	1	0	1
Other	6	3	0	1	1	0	0	1
Middle East	13	2	4	4	1	2	0	0
Israel	8	1	4	3	0	0	0	0
Other	5	1	0	1	1	2	0	0

NOTES: These are official international science and technology agreements only. Bilateral agreements between the Department of State and other countries are broad government-level agreements. In some cases, they provide the formal framework for establishing bilateral agreements detailed in the table. The GAO source report included Russia in its Asia counts; Russia is included here in the Europe totals.

[a] Country counts include bilateral agreements only.

SOURCE: Government Accounting Office. 1999. *Federal Research: Information on International Science and Technology Agreements.* GAO/RCED – 99-108. Washington, DC: GAO.

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Overall, more than 90 percent of the international S&T agreements active in FY 1997 resulted in research projects or other research-related activities. In cases in which this activity did not occur, funding problems that developed after the agreements were signed or changes in research priorities generally were the reasons for their discontinuation.

International S&T collaboration can and does increasingly take place under less formal agreements, however. Consequently, these measures of formal agreements do not necessarily represent the level or intensity of R&D relationships or international collaboration between scientific communities in various countries.[54]

Private-Sector Collaboration

International R&D collaboration is on the rise in the private sector as well—as is indicated by the rising number of formal cooperative agreements or alliances between firms, the growth of overseas R&D activities performed under contract and through subsidiaries, and an increase in the number of R&D laboratories located abroad (OECD 1998a). The expansion of international industrial R&D activity appears to be a response to the same competitive factors that foster domestic collaborations. Firms reach beyond their home borders as a way of addressing rising R&D costs and risks in product development, shortened product life cycles, increasing multidisciplinary complexity of technologies, and intense competition in domestic and global markets.

International Strategic Technology Alliances

Historical Trends

Industrial firms increasingly have used global research partnerships to strengthen their core competencies and expand into technology fields they consider critical for maintaining market share. In these partnerships, organizations can expand opportunities and share risks in emerging technologies and emerging markets. During the first half of the 1970s, strategic alliances were almost nonexistent, but they expanded rapidly late in the decade. For example, the number of newly made partnerships in the three core technologies—information technologies, biotechnology, and new materials—rose from about 10 alliances created in 1970 (Hagedoorn 1996) to about 90 in 1980. R&D-related international strategic technology alliances increased sharply throughout the industrialized world in the early 1980s and accelerated as the decade continued, reaching 580 such partnerships in 1989.[55] In the early 1990s, the annual formation of newly established alliances at first tapered off from that reported in the 1980s and then rapidly increased to a peak of more than 800 new alliances formed in 1995. Since then, there has been a steady decrease in the number formed, to 564 in 1998—a total that nonetheless exceeds the number formed during any year prior to 1989. For the entire 1980–98 period, U.S., European and Japanese firms collectively entered into almost 9,000 strategic technology alliances. Most of these alliances were formed in the 1990s; most involved U.S. firms; and most were signed to foster R&D partnerships in just a few high-tech areas, notably information technologies and biotechnology. (See figure 2-36, text table 2-18, and appendix table 2-67.)

As the number of alliances has increased, the forms of cooperative activity have changed as well. The most prevalent modes of global industrial R&D cooperation in the 1970s were joint ventures and research corporations. In these arrangements, at least two companies share equity investments to form a separate and distinct company; profits and losses are shared according to the equity investment.[56] In the second half of the 1980s and into the 1990s, joint nonequity R&D agreements became the most common form of partnership. Under such agreements, two or more companies organize joint R&D activities to reduce costs and minimize risk while they pursue similar innovations; participants share technologies but have no joint equity linkages (Hagedoorn 1990, 1996).

Country Focus

Between 1990 and 1998, more than 5,100 strategic technology alliances were formed, of which 2,700 were intraregional (that is, made between firms located within the broad regions of Europe, Japan, or the United States) and 2,400 were interregional (between firms located in separate regions). Of course, many of the more than 500 intra-European alliances are also multinational because they generally involve firms from more than one European country (in contrast with the numerous intra-American and much less numerous intra-Japanese firm partnerships in which all partners have the same national ownership). For the 1990–98 period, U.S. companies participated in 80 percent of known technology alliances, about half of which were between two or more U.S. firms and about half of which included a non-U.S. company. European companies participated in 42 percent and Japanese companies in 15 percent of the 5,100 alliances formed in the 1990s. (See text table 2-18).

Consistent with overseas R&D funding trends (detailed below), just a handful of European firms account for most of that region's alliances. Of the 4,700 European alliances re-

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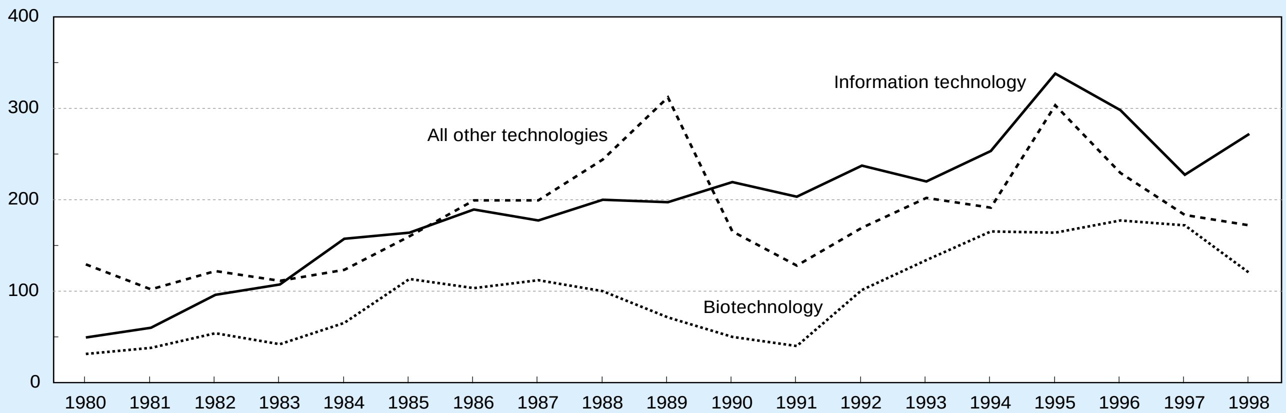
[54]See chapter 6 for information on patterns of international co-authorship.

[55]Information in this section is drawn from an extensive database compiled in the Netherlands— the Maastricht Economic Research Institute on Innovation and Technology's (MERIT 1999) Cooperative Agreements and Technology Indicators (CATI) database—on literally thousands of inter-firm cooperative agreements. The CATI database collects only agreements that contain arrangements for transferring technology or joint research. These counts are restricted to strategic technology alliances, such as joint ventures for which R&D or technology sharing is a major objective; research corporations; and joint R&D pacts. The historical totals reported here differ from those reported in previous *Science & Engineering Indicators*. Previously, alliances of minority holdings coupled with research contracts were included in the totals. Here such alliances are not included in the totals.

CATI is a literature-based database: Its key sources are newspapers, journal articles, books, and specialized journals that report on business events. Its main limitations are that data are limited to activities publicized by the firm, agreements involving small firms and certain technology fields are likely to be underrepresented, reports in the popular press are likely to be incomplete, and it probably reflects a bias because it draws primarily from English-language materials. CATI information should therefore be viewed as indicative and not comprehensive.

[56]Joint ventures are companies that have shared R&D as a specific company objective, in addition to production, marketing, and sales. Research corporations are joint R&D ventures with distinctive research programs.

Figure 2-36.
New international strategic technology alliances, by technology



NOTE: Includes alliances of firms located both within broad regions and across broad regions.

See appendix table 2-67. *Science & Engineering Indicators – 2000*

ported during the entire 1980–98 period (a figure that includes double-counting of partnerships with two or more European firms), the most active participants were British firms (1,036 alliances), German firms (994), French firms (715) and Dutch firms (680). More than 100 alliances were also formed by companies with Italian (338), Swiss (267), Swedish (278), and Belgian (119) ownership. Additionally, a substantial number of the international technology partnerships involved firms located outside of these major regions. During the entire 1980–98 period, Canadian firms entered into 198 strategic technology alliances (mostly with U.S. companies), South Korean firms joined 119, Russian (and other former Soviet Union) firms joined 90,[57] Chinese firms joined 86, Australian firms joined 63, Israeli firms joined 51, and Taiwanese firms joined 48.

Technology Focus

Most intraregional and interregional alliances have been between firms sharing research and technology development in information technologies (IT) and biotechnology. These two technologies alone account for two-thirds of all alliances formed since 1990. The only other technologies for which firms consistently have entered into a substantial number of partnerships relate to advanced materials and non–biotechnology-based chemicals. (See appendix table 2-67.) Forty-four percent of the technology alliances formed worldwide since 1990 dealt with information technologies such as computer software and hardware, telecommunications, industrial automation, and microelectronics. Of the roughly 2,300 IT alliances formed during this period, most have been between U.S. companies (50 percent) or between European and U.S. firms (19 percent). Among the 1,100 strategic biotechnology alliances, the regional distribution has been more diverse, although U.S.-U.S. and U.S.-European interregional partnerships are more prevalent than any other (each type accounting for more than one-third of the biotechnology total). Consistent with R&D funding trends and indicative of known core strengths, U.S.-Japanese collaborations are more common in IT activities than in biotechnology.

International Industrial R&D Investment Growth

Stiff international competition in research-intensive, high-technology products and market opportunities have compelled firms throughout the world to expand their overseas research activities. Foreign sources account for a growing share of domestic R&D investment totals in many countries. (See figure 2-32.) Many firms have R&D sites in countries outside their home base. Although the data are somewhat scant, the share of R&D performed by foreign affiliates appears to have risen perceptibly throughout the OECD during the past two decades (OECD 1998a). Currently, the share of R&D performed by foreign affiliates accounts on average for 14 percent of the industrial R&D performed in OECD countries. This share varies considerably among hosting countries, however—from a low of 1 percent in Japan to a high of 68 percent in Ireland (OECD 1999d).

Although many factors contribute to a business decision to locate R&D capabilities outside a firm's home country, the basic drivers fall into demand-side and supply-side considerations.

Multinational firms seek a foreign R&D presence to support their overseas manufacturing facilities or to adapt standard products to the demand there. R&D facilities are established to customize existing products or to develop new

[57]See Hagedoorn and Sedaitis (1998) for summary data on international strategic technology alliances between Western companies and Russian companies.